



Uteria naghanensis n. sp. (Dasycladale) from the Upper Maastrichtian of Iran

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Abstract: A new dasycladalean alga is described as *Uteria naghanensis* n. sp. from the late Maastrichtian Tarbur Formation of the Zagros Zone, SW Iran. It is a small to medium-sized, rather well calcified species with small articles each bearing one fertile ampulla, alternating with close-set verticils of numerous sterile laterals. Another characteristic is its comparably wide main axis. The genus *Uteria* MICHELIN was so far only known from the Paleogene (Danian-Lutetian). The discovery of *U. naghanensis* n. sp. in inner platform wackestone of the Tarbur Fm. documents the origination of the genus already in the uppermost Cretaceous within an area belonging to the Arabian Plate.

Key-words:

- green algae;
- larger benthic foraminifera;
- systematics;
- palaeobiogeography;
- Arabian Plate

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Résumé : *Uteria naghanensis* n. sp. (*Dasycladale*) du Maastrichtien supérieur d'Iran.- Une algue dasycladale nouvelle, *Uteria naghanensis* n. sp., provenant du Maastrichtien supérieur de la Formation Tarbur du Zagros (sud-ouest de l'Iran) est décrite. Il s'agit d'une espèce de taille petite à moyenne, assez bien calcifiée, avec des petits éléments portant chacun une ampoule fertile, disposés en alternance avec des verticilles serrés constitués de nombreuses latérales stériles. Cette algue est aussi caractérisée par son axe principal assez large. Le genre *Uteria* MICHELIN n'était jusqu'à présent connu que dans le Paléogène (Danien-Lutétien). La découverte d'*U. naghanensis* n. sp. dans des boues bioclastiques de plate-forme interne de la Formation Tarbur atteste de l'apparition du genre dès la partie terminale du Crétacé dans une région rattachée à la Plaque Arabe.

Mots-clefs :

- algues vertes ;
- grands foraminifères benthiques ;
- systématique ;
- paléobiogéographie ;
- plaque arabe

Introduction

The Upper Cretaceous Tarbur Formation, named after the village of Tarbur (Fars Province), and cropping out in the SW Zagros basin, represents a predominantly carbonate lithostratigraphic unit that contains rich microfauna and microflora associated with rudists (JAMES & WYND,

1965). It extends from the northwest to the southeast of the Zagros basin along the western edge of the imbricated Zagros zone, between the main Zagros fault and the Sabzposhan fault to the east (ALAVI, 2004). The Tarbur Formation overlies and interfingers (towards the southwest) with the Gurpi Formation.

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Figure 1: Location of the Naghan and Mandegan sections (the background is an excerpt from Google Maps)

The microflora of the Tarbur Formation is rather poorly known and consists almost exclusively of calcareous green algae with a clear dominance of Dasycladales. Some taxa of dasycladalean algae were illustrated in a few recently published papers (ABYAT *et al.*, 2012, 2015; AFGHAH & FARHOUDI, 2012; AFGHAH & YAGHMOUR, 2014; AFGHAH, 2016; DEGHANI *et al.*, 2016; KHOSROW TEHRANI & AFGHAH, 2004). These determinations however are dubious if not incorrect and therefore require further investigation. First results and critical revisions of the microflora of the Tarbur Formation

were published recently (RASHIDI *et al.*, 2013; SCHLAGINTWEIT *et al.*, 2016c; RASHIDI & SCHLAGINTWEIT, 2018a, 2018b). The taxa identified so far include *Clypeina* sp. (rare), *Dissocladella* n. sp., *Pseudocymopolia anadyomenea* (ELLIOTT) (common to abundant), *Salpingoporella pasmanica* RADOIČIĆ (common), *Zittelina ? arumaensis* (OKLA) (rare to common), and *Suppiluliumaella tarburensis* RASHIDI & SCHLAGINTWEIT (common). Compared to the (larger) benthic foraminifera, the microflora is less diversified. In the present paper a new common to abundant dasycladale is described as *Uteria naghanensis* n. sp. The material comes from two sections of the Tarbur Formation.

Studied sections

The studied samples are from two sections of the Tarbur Formation (Fig. 1).

A) Naghan section

The studied area in the folded Zagros belt is located approximately 50 km south west of Naghan town near Gandomkar village and is here named the Naghan section. In this locality, the Tarbur Formation unconformably rests on the Gurpi Formation and is overlain by the Paleocene Sachun Formation. Lithologically, the Gurpi Formation consists of dark shales, grey calcareous shales containing planktonic foraminifera. The Sachun Formation consists of gypsum, red shales, anhydrite and some layer of carbonates.

The thickness of the Tarbur Formation at the Naghan section is about 274 m. It is composed of medium to thick-bedded grey limestone, shales and marls and can be subdivided into five units:

- unit 1 (99 m), red to yellow shales;
- unit 2 (61 m), medium- to thick-bedded grey limestones with *Loftusia* and rudist debris (calcarenites to calcirudites);

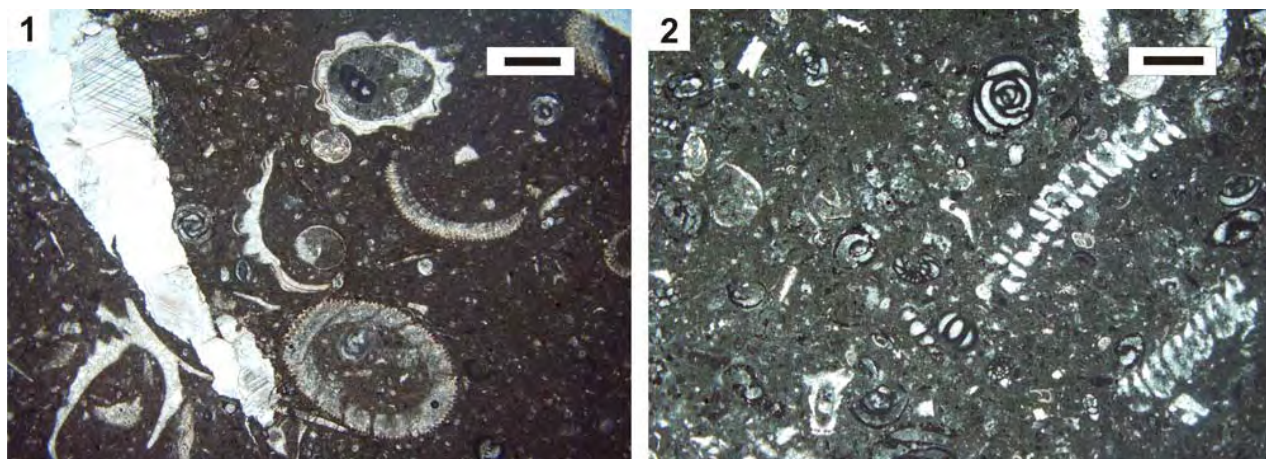


Figure 2: Microfacies with *Uteria naghanensis* n. sp. from the Naghan section. 1. Wackestone with small rudists. Thin-section 2NG 197. Scale bar 0.9 mm. 2. Wackestone with miliolids among *Pseudonummoloculina kalantarii* SCHLAGINTWEIT & RASHIDI. Thin-section N 83. Scale bar 0.6 mm.

- unit 3 (33 m), intercalation of grey shales and cream to grey, medium- to thick-bedded limestones (calclutites and calcarenites);
- unit 4 (38 m), thick-bedded to massive, grey to cream-coloured limestones containing broken rudist shells and tests of *Loftusia* (calcarenites, calclutites to calcirudites);
- unit 5 (~ 41.6 m), shales interbedded with medium- to thick-bedded yellow limestones containing *Loftusia* fragments.

The total vertical distribution of *Uteria naghanensis* n. sp. is shown in Figure 3, along with other dasycladales and some of the larger benthic foraminifera. The new species occurs in generally poorly diversified foraminiferal-algal wackestone (Fig. 2). It may be associated with small rudists, and dasycladales *Pseudocymopolia anadyomenea* (ELLIOTT), and *Salpingoporella pasmanica* RADOIČIĆ. Among the benthic foraminifera small miliolids and rotalids are typically co-occurring as well as large forms such as *Dicyclina schlumbergeri* MUNIER-CHALMAS, *Broeckinella arabica* HENSON, *Persiella pseudolituus* SCHLAGINTWEIT & RASHIDI, *Spirolina* ? *farsiana* SCHLAGINTWEIT & RASHIDI and more rarely *Omphalocyclus macroporus* LAMARCK, and *Neobalkhania bignoti* CHERCHI *et al.* (Fig. 3). The Greenwich coordinates of the section base are N 31°47'52" and E 50°32'53".

B) Mandegan section

The study area, located in the High Zagros Belt, is situated north of Mount Dena, about 65 km south of the town of Semirom. The section of the Tarbur Formation is exposed about 10 km south of the village of Mandegan, and was named the Mandegan section (for further details of the location see SCHLAGINTWEIT *et al.*, 2016a). There the Tarbur Formation with a thickness of ~272 m conformably overlies the Gurpi Formation. The top of the section is unconformably overlain by conglomerates of the Pliocene Bakhtiari Formation. Based on the lithostratigraphy, the section has been subdivided into three units (from base to top): unit 1 is dominated by thick-bedded li-

mestones, unit 2 mostly contains medium-bedded limestones with intercalated marly limestone layers, and unit 3 consists of marly limestone. The microfacies with *Uteria naghanensis* n. sp. is equivalent to the one from the Naghan section. The Greenwich coordinates of the Mandegan section base are N 31°25'8.13" and E 51°24'34.58".

Material and depository

All specimens from *Uteria naghanensis* n. sp. are from thin-sections stored at the Ardakan Payame Noor University, Iran, in the RASHIDI collection, under the original sample numbers with the prefixes NG and 2NG for the Naghan, and Rt for the Mandegan sections. Twenty thin-sections from the Mandegan section have been stored at the Bayerische Staatssammlung für Paläontologie und historische Geology, Munich, under the official number SNSB-BSPG 2016 V 1 to V 20. They have been stored in the framework of the orbitolinid study of the authors (SCHLAGINTWEIT *et al.*, 2016b).

Systematics

Phylum Chlorophyta

Class Dasycladophyceae

Oder Dasycladales PASCHER, 1931

Family Polyphysaceae (KÜTZING, 1843)

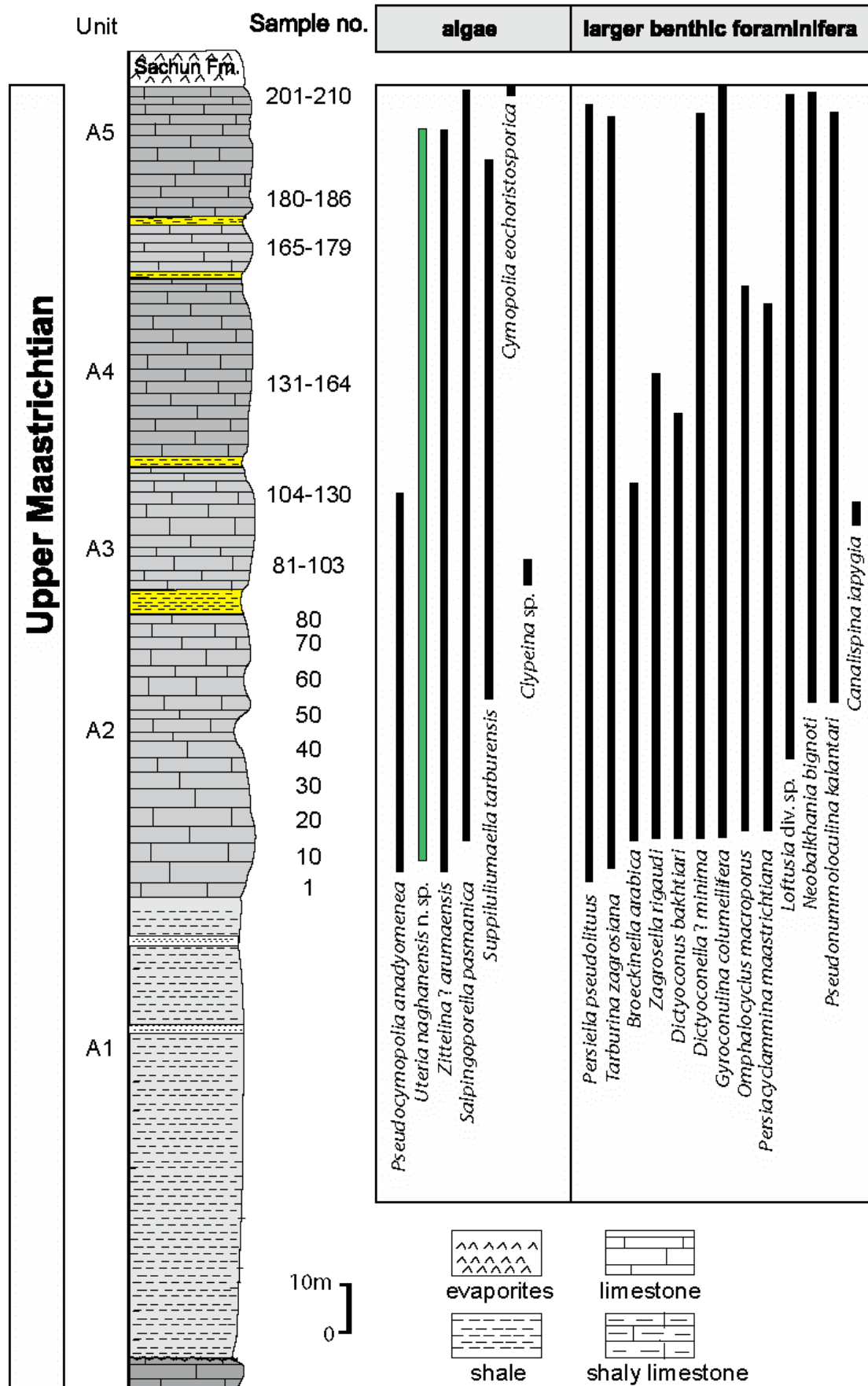
Tribe Uterieae

(L. MORELLET & J. MORELLET, 1922),
BASSOULLET *et al.*, 1979

Genus *Uteria* (MICHELIN, 1845),
DIENI & RADOIČIĆ, 1985

Type-species: *Uteria encrinella* MICHELIN, 1845.

Remarks: Based on which was previously known (*e.g.*, DELOFFRE & GÉNOT, 1982) the genus *Uteria* was emended by DIENI and RADOIČIĆ (1985)





with respect to the order of laterals. The emendation was based on one longitudinal section of *U. sarda* DIENI *et al.* from the Paleocene of Sardinia, and one oblique section of *U. cf. brochii* L. MORELLET & J. MORELLET from the Paleocene of Slovenia. The sterile laterals display a more or less constant diameter, only in the distal part do they widen towards the thallus surface. For two verticils, a small central depression of the distal end is visibly covered by a thin layer of calcite (? remnant of the original algal skeleton). Therefore the terminal end of the laterals displays a (seemingly?) bifurcating aspect interpreted by DIENI and RADOIČIĆ (1985) as secondaries. For the section of the Slovenian specimen, tufts of tiny tertiary laterals at the end of the fertile vertical are illustrated. Neither from the type-species *U. encrinella* MICHELIN nor any other species have these higher order laterals been observed later in the literature. We may presume that their occurrence (interpretation?) was doubted by subsequent authors (*e.g.*, DELOFFRE *et al.*, 1989, p. 5 "si elles existent" ?). Also the short summarized diagnosis presented by GÉNOT & GRANIER (2011) does not refer to the existence of higher order laterals: "Segmented thallus. Alternation along the stalk of whorls of slender sterile lateral segments and of very enlarged fertile segments bearing short secondary segments".

Uteria naghanensis n.sp.

(Pls. 1 - 2 - 3)

Origin of the name: The species name refers to the type-locality situated near Naghan town.

Holotype: Longitudinal-oblique section illustrated in Pl. 1, fig. 1, thin-section NG 60.

Type locality: Naghan section (Fig. 1).

Type level: Mud supported limestones (wackestone, packstone) with small and larger benthic foraminifera, dasycladales, and small rudists of the Tarbur Formation.

Diagnosis: Medium-sized, well and uniform calcified representative of *Uteria* displaying a rather wide axial cavity. The articulated thallus consists of regularly alternating sterile verticils and fertile verticils. The sterile verticils consist of numerous tubular and laterally attaching laterals. The fertile verticils contain each one swollen fertile ampulla bearing numerous short laterals at their distal surface.

◀ **Figure 3:** Vertical distribution of selected dasycladales, including *Uteria naghanensis* n. sp. (green bar), and some larger benthic foraminifera in the Late Maastrichtian of the Tarbur Formation of the Naghan section.

Description: Thallus cylindrical, occasionally slightly bended, consisting up sparry calcite. The comparably (for the genus!) strong calcification comprises both main axis and laterals (Pl. 1, fig. 1). Obviously due to the wackestone facies and/or strong calcification, long fragments composed of numerous articles are common (Pl. 1, fig. 1). Smaller fragments often with 3 to 5 linked articles (Pl. 1, fig. 7). The articulated thallus aspect is well discernible in longitudinal section and due to an insertion at the plane of the sterile laterals. The thallus consists of alternating fertile and sterile laterals arranged perpendicular to slightly inclined towards the main axis. Articles (between two successive sterile verticils) display a rectangular shape with a slightly convex outer side in axial sections (Pl. 1, fig. 7; Pl. 3, fig. 2). Each article consists of a layer with numerous primary fertile laterals. In vertical section these are subglobular often displaying a flattened distal side (Pl. 1, fig. 5). Occasionally tapering "bulges" at the proximal parts of the fertile lateral are discernible (Pl. 1, fig. 7, left side). They could correspond to neighboring pores. Each fertile lateral is connected to the main axis by means of a central tubular pore slightly widening to the former. These pores lie exactly in horizontal planes. At the distal surface numerous short secondaries arise that are slightly widening throughout most of their length. Towards the exterior surface they show a more marked widening. In shallow tangential section the secondaries form a close-set and alternating pattern (Pl. 3, fig. 8). The sterile laterals are thin, tubular and display a distal widening (Pl. 2, figs. 5-6). Secondary laterals arising from the distal ends have not been observed.

Comparisons: The genus *Uteria* includes 7 species so far: type-species *Uteria encrinella* MICHELIN, 1845 (Ypresian-Bartonian of France), *Uteria brochii* L. MORELLET & J. MORELLET, 1922 (?Ypresian of Belgium), *Uteria merienda* (ELLIOTT, 1968), RADOIČIĆ, 1990 (Paleocene of Iraq), *Uteria sarda* DIENI *et al.*, 1983 (Danian-Selandian of Sardinia, Italy), *Uteria irregularis* DIENI *et al.*, 1985 (Danian-Selandian of Sardinia, Italy), *Uteria medizzai* DIENI *et al.*, 1985 (Danian-Selandian of Sardinia, Italy), *Uteria mexicana* DELOFFRE *et al.*, 1989 (upper Paleocene or lower Eocene of Mexico). The comparison table (**Table 2** below) concludes that *Uteria naghanensis* n. sp. differs from the other species by its small articles (H), length of sterile laterals (~ wall thickness) (I), and just one fertile ampulla per article (g). The number of sterile laterals per vertical is in the range indicated for other species.



Dimensions: The main biometric parameters are compiled in **Table 1** below.

no.	sample	L	D	d	d/D	w	H	I	p fert.	I'
1	NG 10	3.2	2.1	1.5	0.72	-	0.24	0.29	0.19	0.08
2	NG 49	-	3.6	2.6	0.73	-	0.48	0.48	0.27	-
3	NG 59	-	2.4	1.8	0.75	-	-	-	-	-
4	NG 60	4.7	2.4	1.5	0.64	-	0.31	0.36	-	-
5	NG 83	-	2.6	1.68	0.65	-	0.31	0.42	0.22	-
6	NG 85	-	1.54	1.0	0.68	-	-	-	-	-
7	NG 85	-	1.2	0.74	0.62	72	-	0.21	-	-
8	NG 85-1	-	2.7	1.6	0.59	-	0.36	0.55	0.26	0.12
9	NG 117	5.2	3.2	2.2	0.69	-	0.36	0.54	0.31	0.17
10	NG 117	-	3.1	2.2	0.71	124	-	0.5	-	-
11	NG 121	-	2.2	1.7	0.77	-	-	0.32	-	-
12	NG 123	-	3.55	2.3	0.65	-	-	-	-	-
13	NG 117	-	3.1	2.2	0.71	124	-	-	-	-
14	2NG 49	6.6	3.17	1.6	0.50	-	0.43	0.85	0.2	0.24
15	2NG 76	-	3.2	2.0	0.64	-	0.43	0.53	0.32	0.08
16	2NG 76	8.8	2.0	1.26	0.63	-	0.36	0.43	0.25	0.16
17	2NG 79	4.58	1.7	1.0	0.61	-	0.26	0.37	-	0.12
18	2NG 85-4	-	3.2	1.9	0.6	-	0.5	0.5	0.33	0.12
19	2NG 85-4	-	2.9	1.8	0.62	-	-	0.5	-	-
20	2NG 91	5.8	2.5	1.2	0.48	-	0.4	0.6	0.28	-
21	2NG 94	-	2.2	1.54	0.7	-	0.35	0.32	0.22	0.11
22	2NG 123	6.3	-	-	-	-	0.32	-	-	-
23	2NG 197	-	2.3	1.44	0.63	-	0.44	0.43	0.26	-
24	Rt 67-2	-	2.8	1.9	0.68	-	0.48	0.57	0.42	0.14
25	Rt 86	9.7	2.3	1.3	0.56	-	0.3	0.47	-	-
26	Rt 86	-	1.4	0.8	0.57	76	-	0.3	-	-
27	Rt 86	5.6	2.4	1.6	0.67	-	0.31	0.42	0.24	0.15
28	Rt 89-3	-	2.4	1.6	0.66	-	0.28	0.39	-	-
29	Rt 98-3	-	2.5	1.9	0.76	-	0.34	0.31	0.23	-
31	Rt 98-3	-	2.4	1.45	0.6	-	0.35	0.4	0.26	0.13
31	Rt 98-3	6.25	2.6	1.70	0.65	-	0.32	0.4	0.24	-
Range (max.)		(9.7)	1.4-3.6	0.74-2.60	0.48-0.77	72-124	0.24-0.50	0.21-0.85	0.19-0.42	0.08-0.24
Mean		-	2.5	1.6	0.65	-	0.33	0.42	0.25	0.135

Stratigraphy: The occurrence of *Canalispina iapygia* ROBLES-SALCEDO *et al.*, 2018, in the samples NG 99-101 of the Naghan section is worth mentioning, as this taxon has its first appearance in the late Maastrichtian (according to ROBLES-SALCEDO *et al.*, 2018). This age assignment is also supported by some of the other larger benthic foraminifera, such as *Neobalkhania bignoti*. For the Mandegan section, the Upper Maastrichtian is evidenced with an association of orbitoids and *Siderolites calcitrapoides*, *Canalispina iapygia* ROBLES-SALCEDO *et al.* in the lower part followed upwards by the dasycladalean-bearing strata (see SCHLAGINTWEIT *et al.*, 2016a, for further details).

Dim. (mm)	U. naghanensis n. sp.	U. brochii L. MORELLET & J. MORELLET	U. cf. brochii (DIENI & RADOIČIĆ)	U. sarda DIENI <i>et al.</i>	U. irregularis DIENI <i>et al.</i>	U. medizai DIENI <i>et al.</i>	U. mexicana DELOFFRE <i>et al.</i>	U. merlenda (ELLIOTT)	U. encrinella MICHELIN
D	1.4-3.6	1.5-2.5	2.00-2.56	3.92-5.04	2.48-3.68	2.08-2.24	1.25-2.37	Up to 2.5	0.9-3.0
d	0.74-2.60	0.7-1.0	0.88-1.28	1.92-2.40	1.30-1.76	1.28-1.76	0.81-1.31	Up to 1.0	0.28-0.80
d/D	0.48-0.77	0.40-0.46	0.44-0.50	0.47-0.48	0.47-0.52	0.69	0.55-0.64	-	0.24-0.36
H	0.24-0.5	0.8-1.2	0.75-1.28	0.88-1.66	0.96	0.48-0.80	0.68-1.87	-	0.44-1.2
I	0.21-0.86	-	-	-	< 0.86	-	0.43-0.62	-	-
w	72-124	40-50	~40	100-120	< 70	40-50?	30-40?	50 or more	40-50
g	1	1-3	-	2-3	2	-	2 (3)	-	6
p _{fert.}	0.19-0.42	-	-	-	-	-	-	-	-
Stratigr.	Upper Maastr.	Selandian	Selandian?	Danian-Thanelian	Danian-Thanelian	Danian-Thanelian	Selandian-Ypresian	Danian-Thanelian	Ypresian-Lutetian

Concluding remarks

Uteria represents a dasycladalean alga that was previously believed to be an exclusively Paleogene genus (DELOFFRE & GRANIER, 1992; BUCUR, 1999, Table 10; BARATTOLO, 2002, Table 1). The Iranian finds from the late Maastrichtian of the Tarbur Formation show that the genus originated in the Late Cretaceous passing the K/Pg boundary. Another example includes *Jodotella* MORELLET & MORELLET (see DELOFFRE & GÉNOT, 1982, Table 1) reported later from the Maastrichtian (PARENTE, 1997) and late Santonian (SCHLAGINTWEIT, 2004). Analyzing the taxonomic inventories of Late Cretaceous and Paleogene dasycladaleans, especially at the K/Pg boundary, BARATTOLO (2002, p. 21) concluded that in the Maastrichtian the "environmentally restricted facies show a fundamental scarcity in the algal content if compared to similar, younger Paleocene facies. On the other hand, evidence of a moderately rich and diversified upper Maastrichtian microflora is recorded in open shelf/margin facies". The latter statement is referring essentially to the Ciolo Limestone of



Southern Italy (e.g., PARENTE, 1997). The microflora observed from the Tarbur Formation represents an example of inner platform facies that can be considered not really impoverished but of moderate diversity (e.g., *Clypeina* sp., *Dissocladella* n. sp., *Salpingoporella pasmanica*, *Zittellina? arumaensis*, *Cymopolia eochoristosporica*, *Uteria naghanensis*, and some other undescribed taxa). Unfortunately the Tarbur Formation obviously did not pass into the early Paleogene as some authors believe (see discussion in SCHLAGINTWEIT *et al.*, 2016a). This hinders providing further indicators on the effect of the K/Pg boundary event to dasycladaleans (BARATTOLO, 2002, for details).

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Plates

Plate 1: *Uteria naghanensis* n.sp.

Naghan (1-5), Mandegan (6-7) sections, upper Maastrichtian of Iran. Scale bars 1 mm, except 5 = 0.5 mm.

Fig. 1: Longitudinal-oblique section; holotype specimen. Thin-section NG 60.

Fig. 2: Longitudinal-oblique section. Thin-section 2NG 49.

Fig. 3: Tangential section. Thin-section 2NG 83.

Fig. 4: Oblique section. Thin-section 2NG 85.

Fig. 5: Fragmentary longitudinal section. Thin-section NG 82.

Fig. 6: Oblique section. Thin-section Rt 67.

Fig. 7: Longitudinal section of three segments. Note the bulges at the proximal part of the fertile lateral (arrows). Thin-section Rt 67-2.

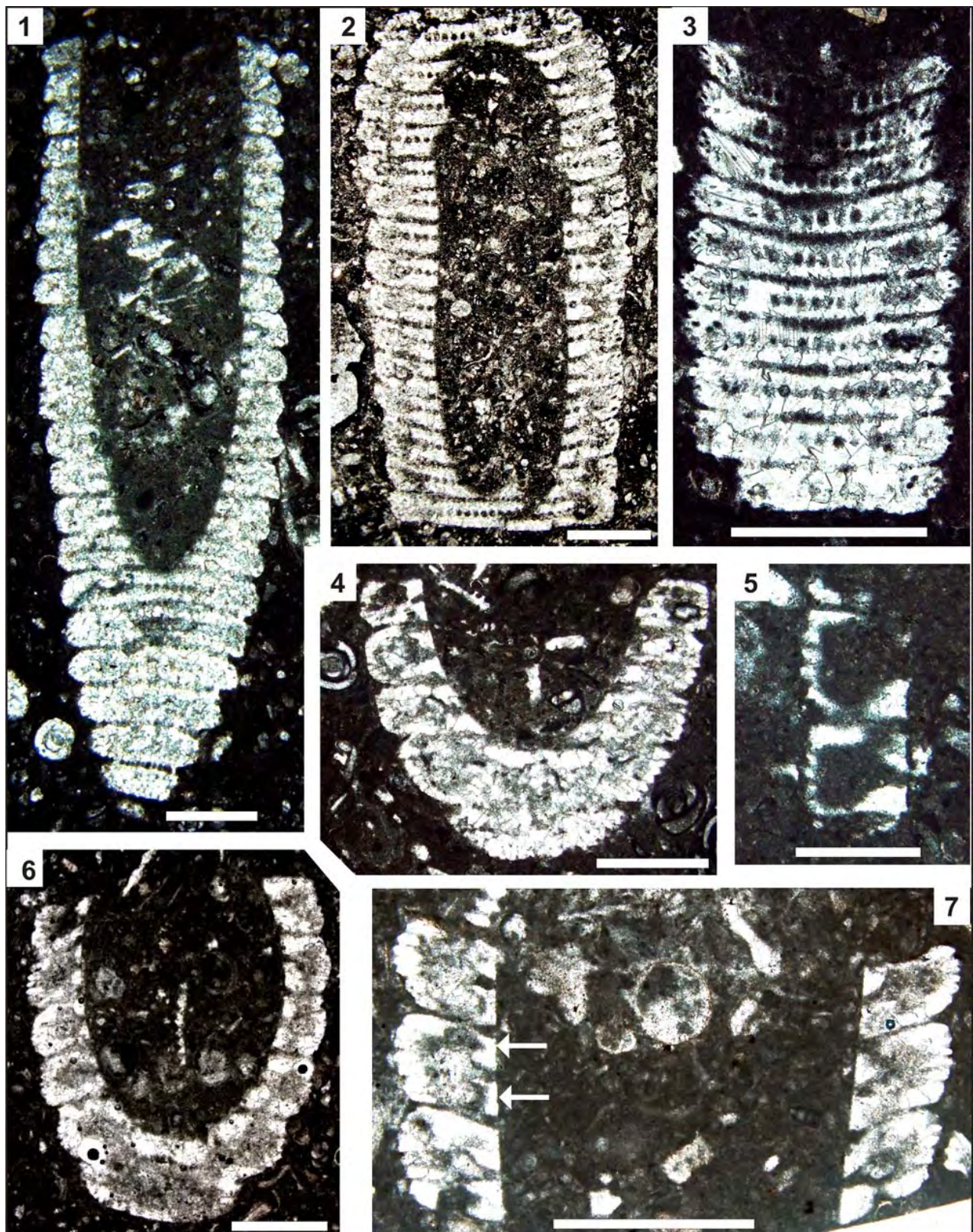




Plate 2: *Uteria naghanensis* n.sp.

Naghan (1-4, 7-8), Mandegan (5-6) sections, upper Maastrichtian of Iran. Scale bars 1 mm.

Fig. 1: Oblique section. Thin-section 2NG 85.

Fig. 2: Longitudinal-oblique section. Thin-section NG 10.

Fig. 3: Oblique section. Thin-section 2NG 83.

Fig. 4: Longitudinal section cutting six segments. Thin-section NG 83.

Fig. 5: Slightly oblique transverse section through sterile verticil. Thin-section Rt 67.

Fig. 6: Slightly oblique transverse section through sterile verticil. Thin-section Rt 67-2n.

Fig. 7: Longitudinal oblique section. Thin-section 2NG 91.

Fig. 8: Oblique section (right), and transverse sections through through sterile verticils. Thin-section NG 117.

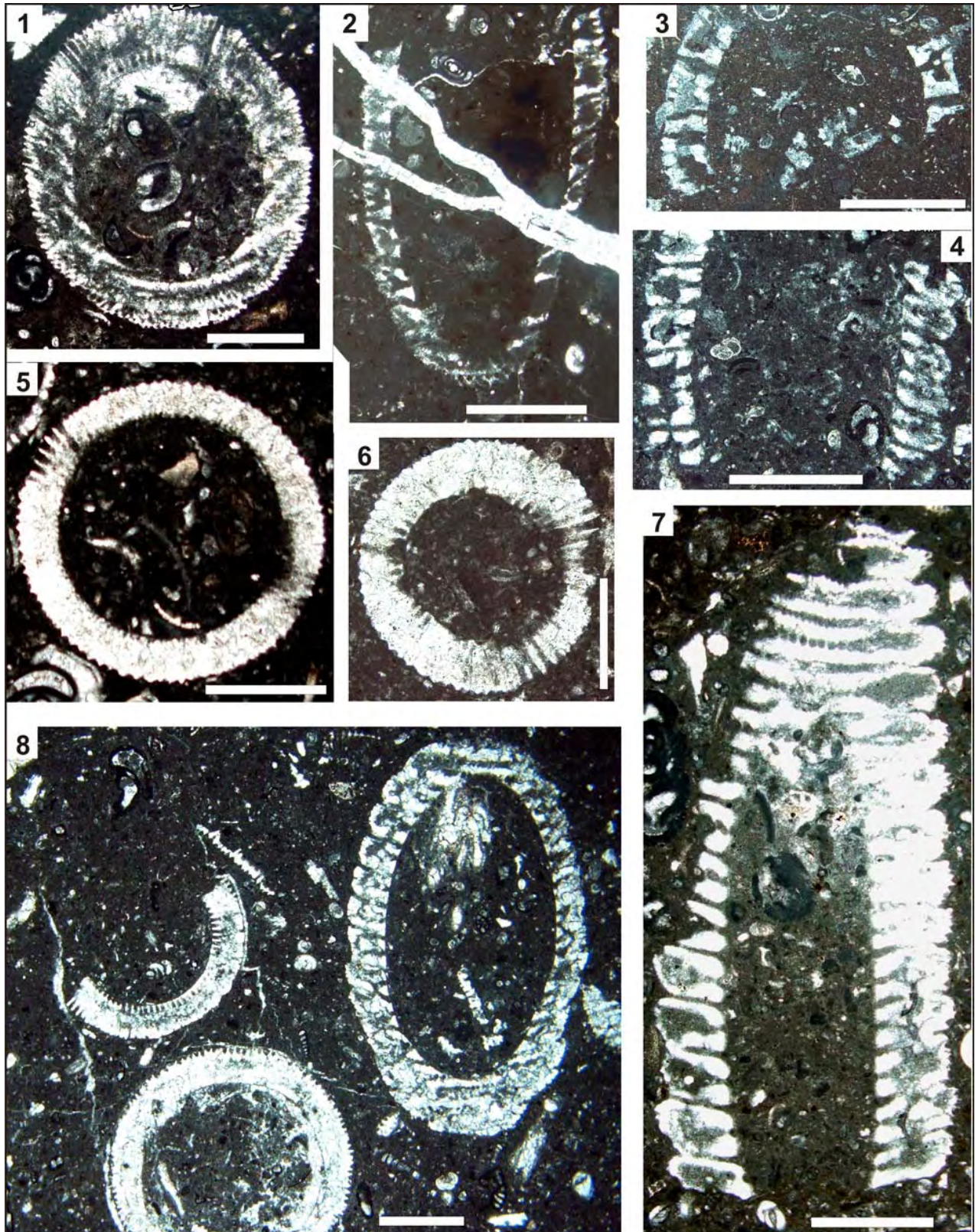




Plate 3: *Uteria naghanensis* n.sp.

Naghan (1, 5, 7), Mandegan (2-4, 6, 8) sections, upper Maastrichtian of Iran. Scale bars 1 mm.

Fig. 1: Two oblique sections. Thin-section 2NG 85.

Fig. 2: Oblique section. Thin-section Rt 67-3.

Fig. 3: Tangential-oblique section. Thin-section Rt 98.

Fig. 4: Longitudinal section cutting six segments cutting 19 segments. Thin-section Rt 86.

Fig. 5: Slightly oblique transverse section through sterile verticil. Thin-section 2NG 197.

Fig. 6: Tangential section cutting 7 segments. Thin-section Rt 98-3.

Fig. 7: Longitudinal section. Thin-section NG 85-1.

Fig. 8: Tangential section. Thin-section Rt 72.

